

CLAIMS

1. A dental caries detecting device, comprising:

an ultraviolet light source;

a fluorescence receiving portion that receives fluorescence from a tooth in response to ultraviolet irradiation from the ultraviolet light source;

a fluorescence data analysis portion that analyzes fluorescence data transmitted from the fluorescence receiving portion; and

a data display portion that displays data analyzed by the fluorescence data analysis portion,

said fluorescence data analysis portion analyzing the fluorescence data based on the fluorescence intensities in at least two wavelength bands in a visible light range.

2. A dental caries detecting device, comprising:

an ultraviolet light source;

a fluorescence receiving portion that receives fluorescence from a tooth in response to ultraviolet irradiation from the ultraviolet light source;

a fluorescence data analysis portion that analyzes fluorescence data transmitted from the fluorescence receiving portion; and

a data display portion that displays data analyzed by the fluorescence data analysis portion,

said fluorescence data analysis portion analyzing data based on a plurality of fluorescence intensities in at least one wavelength band that changes in response to change in the light intensity of said ultraviolet irradiation.

3. The dental caries detecting device according to claim 1 or 2, wherein said fluorescence data analysis portion calculates the degree of progress of dental caries based on said fluorescence intensity in a first wavelength band selected in a wavelength band from 550 nm to 810 nm and having a wavelength width from 0.1 nm to 260 nm, and said fluorescence intensity in a second wavelength band selected from a wavelength band from 380 nm to 550 nm and having a wavelength width from 0.1 nm to 170 nm.

4. The dental caries detecting device according to claim 1 or 2, wherein said fluorescence data analysis portion calculates the degree of progress of dental caries

based on said fluorescence intensity in a first wavelength band selected from a wavelength band from 550 nm to 810 nm and having a wavelength width from 0.1 nm to 260 nm, and one or more of said fluorescence intensity in a second wavelength band selected from a wavelength band from 380 nm to 550 nm and having a wavelength width from 0.1 nm to 170 nm and said fluorescence intensity in a third wavelength band selected from a wavelength band from 450 nm to 650 nm and having a wavelength width from 0.1 nm to 200 nm.

5. The dental caries detecting device according to any one of claims 1 to 4, wherein said fluorescence receiving portion comprises an optical device that can extract information related to said fluorescence intensity in said first wavelength band and said second and/or third wavelength band from said visible light range.

6. The dental caries detecting device according to claim 5, wherein said optical device is one of a spectroscopic luminance meter, a color CCD, a CMOS, or an optical sensor with a color filter for at least two colors.

7. The dental caries detecting device according to claim 5 or 6, wherein the output intensity of said ultraviolet light source is adjustable.

8. The dental caries detecting device according to claim 7, wherein said ultraviolet light source is an ultraviolet LED.

9. A dental caries detecting method that irradiates a measuring area of a tooth with ultraviolet light from a light source and detects a dental caries based on fluorescence from the measuring area, including:

a first step of obtaining fluorescence information from said measuring area;

a second step of obtaining the intensity of said fluorescence in at least two wavelength bands selected from a first wavelength band selected from a wavelength band from 550 nm to 810 nm and having a wavelength width from 0.1 nm to 260 nm, a second wavelength band selected from a wavelength band from 380 nm to 550 nm and having a wavelength width from 0.1 nm to 170 nm and a third wavelength band selected from a wavelength band from 450 nm to 650 nm and having a wavelength width from 0.1 nm to 200 nm based on said obtained fluorescence information; and

a third step of carrying out calculation based on said fluorescence intensities and determining the presence/absence of dental caries and/or the degree of progress of dental caries based on the result of said calculation.

10. The dental caries detecting method according to claim 9, wherein said third step includes the steps of:

a step (3.1) of calculating a dental caries degree CD_1 based on the intensity R of fluorescence in said first wavelength band, and the intensity B of fluorescence in said second wavelength band or the intensity G of fluorescence in said third wavelength band according to the following formula (1) or (2):

$$CD_1 = R/B \quad \dots \text{formula (1)}$$

$$CD_1 = R/G \quad \dots \text{formula (2)}$$

a step (3.2) of comparing the value of said dental caries degree CD_1 and a lower threshold E_1 ; and

a step (3.3) of determining the presence of dental caries if the value of said dental caries degree CD_1 is larger than said lower threshold E_1 , and determining the tooth as being healthy if the value of said dental caries degree CD_1 is equal to or smaller than said lower threshold E_1 .

11. The dental caries detecting method according to claim 10, further including:

a step (3.4) of comparing the value of said dental caries degree CD_1 and the upper threshold F_1 if the presence of dental caries is determined in said step (3.3); and

a step (3.5) of determining the presence of severe dental caries if the value of said dental caries degree CD_1 is larger than the upper threshold F_1 and determining the presence of minor dental caries if the value of said dental caries degree CD_1 is equal to or smaller the upper threshold F_1 .

12. A dental caries detecting method that irradiates a measuring area of a tooth with ultraviolet light from a light source and detects a dental caries based on fluorescence from the measuring area, including:

a first step of, when there are two said measuring areas, obtaining fluorescence from said measuring areas as first and second information;

a second step of obtaining said fluorescence intensities in at least two wavelength bands selected from a first wavelength band selected from a wavelength

band from 550 nm to 810 nm and having a wavelength width from 0.1 nm to 260 nm, a second wavelength band selected from a wavelength band from 380 nm to 550 nm and having a wavelength width from 0.1 nm to 170 nm, and a third wavelength band selected from a wavelength band from 450 nm to 650 nm and having a wavelength width from 0.1 nm to 200 nm based on said first and second information;

a third step of calculating a dental caries degree CD_2 based on said fluorescence intensities according to the following formula (3) or (4):

$$CD_2 = |R_n - R_c| \times |B_n - B_c| \quad \dots \text{formula (3) or}$$

$$CD_2 = |R_n - R_c| \times |G_n - G_c| \quad \dots \text{formula (4)}$$

where R_n is the fluorescence intensity in the first wavelength band in the first information, B_n is the fluorescence intensity in the second wavelength band in the first information, G_n is the fluorescence intensity in the third wavelength band in the first information, R_c is the fluorescence intensity in the first wavelength band in the second information, B_c is the fluorescence intensity in the second wavelength band in the second information, and G_c is the fluorescence intensity in the third wavelength band in the second information;

a fourth step of comparing the value of said dental caries degree CD_2 and the lower threshold E_2 ; and

a fifth step of determining the presence of dental caries if the value of said dental caries degree CD_2 is larger than the lower threshold E_2 , and determining the tooth as being healthy if the value of said dental caries degree CD_2 is equal to or smaller than the lower threshold E_2 .

13. The dental caries detecting method according to claim 12, further including:

a step (5.1) of comparing the value of said dental caries degree CD_2 and the upper threshold F_2 if the presence of dental caries is determined in said fifth step; and

a step (5.2) of determining the presence of severe dental caries if the value of said dental caries degree CD_2 is larger than said upper threshold F_2 and determining the presence of minor dental caries if the value of said dental caries degree CD_2 is equal to or smaller than said upper threshold F_2 .

14. A dental caries detecting method that irradiates a measuring area of a tooth with ultraviolet light from a light source and detects dental caries based on fluorescence from the measuring area, including:

a first step of obtaining fluorescence from said measuring area for at least two different light intensities among light intensities U_1, U_2, \dots , and U_n where $U_1 > U_2 > \dots > U_n$ as first, second, ..., and n-th information, respectively;

a second step of obtaining first fluorescence intensities R_1, B_1 , and G_1 , second fluorescence intensities R_2, B_2 , and G_2 , ..., and n-th fluorescence intensities R_n, B_n , and G_n of said fluorescence in at least two wavelength bands selected from a first wavelength band selected from a wavelength band from 550 nm to 810 nm and having a wavelength from 0.1 nm to 260 nm, a second wavelength band selected from a wavelength band from 380 nm to 550 nm and having a wavelength width from 0.1 nm to 170 nm, and a third wavelength band selected from a wavelength band from 450 nm to 650 nm and having a wavelength width from 0.1 nm to 200 nm based on said first information, second information, ..., and n-th information;

a third step of carrying out calculation according to the following formula (5):

$$(R_1 - R_2) + (R_2 - R_3) + \dots + (R_{n-1} - R_n) \quad \dots \text{formula (5)}$$

and

a fourth step of determining that there is a possibility of dental caries if the sign of a result obtained from formula (5) is positive, and determining that the tooth is healthy if the sign is negative or the result is zero.

15. The dental caries detecting method according to claim 14, further including:

a step (4.1) of calculating a dental caries degree CD_3 according to the following formula (6) if it is determined in said fourth step that there is a possibility of dental caries,

$$CD_3 = (R_{n-1}/R_n) \times (B_{n-1}/B_n) \quad \dots \text{formula (6)}$$

a step (4.2) of comparing the value of said dental caries degree CD_3 and an upper threshold F_3 ;

a step (4.3) of determining the tooth as being healthy if the value of said dental caries degree CD_3 is equal to or larger than said upper threshold F_3 and determining the presence of dental caries if the value of said dental caries degree CD_3 is smaller than said upper threshold F_3 .

16. The dental caries detecting method according to claim 15, further including:

a step (4.4) of comparing the value of said dental caries degree CD_3 and a lower threshold E_3 if the presence of dental caries is determined in said step (4.3); and

a step (4.5) of determining that the dental caries is minor if the value of said dental caries degree CD_3 is equal to or larger than said lower threshold E_3 , and determining that the dental caries is severe if the value of said dental caries degree CD_3 is smaller than said lower threshold E_3 .

5 17. The dental caries detecting method according to claim 14, further including:

a step (4.1) of calculating a dental caries degree CD_4 according to the following formula (7) if it is determined in said fourth step that there is a possibility of dental caries,

$$CD_4 = (R_{n-1}/R_n) \times (G_{n-1}/G_n) \quad \dots \text{formula (7)}$$

10 a step (4.2) of comparing the value of said dental caries degree CD_4 and an upper threshold F_4 ; and

a step (4.3) of determining the tooth as being healthy if the value of said dental caries degree CD_4 is equal to or larger than said upper threshold F_4 , and determining the presence of dental caries if the value of said dental caries degree CD_4 is smaller than
15 said upper threshold F_4 .

18. The dental caries detecting method according to claim 17, further including:

a step (4.4) of comparing the value of said dental caries degree CD_4 and a lower threshold E_4 if the presence of dental caries is determined in said step (4.3); and

a step (4.5) of determining that the dental caries is minor if the value of said
20 dental caries degree CD_4 is equal to or larger than said lower threshold E_4 and determining that the dental caries is severe if the value of said dental caries degree CD_4 is smaller than said lower threshold E_4 .

19. The dental caries detecting method according to claim 14, further including:

a step (4.1) of calculating a dental caries degree CD_5 according to the following
25 formula (8) if it is determined in said fourth step that there is a possibility of dental caries,

$$CD_5 = (R_{n-1}/R_n) \times \{(G_{n-1}/G_n) + (B_{n-1}/B_n)\} \quad \dots \text{formula (8)}$$

a step (4.2) of comparing the value of said dental caries degree CD_5 and an upper threshold F_5 ; and

30 a step (4.3) of determining the tooth as being healthy if the value of said dental caries degree CD_5 is equal to or larger than said upper threshold F_5 , and determining the

presence of dental caries if the value of said dental caries degree CD_5 is smaller than said upper threshold F_5 .

20. The dental caries detecting method according to claim 19, further including:

5 a step (4.4) of comparing the value of said dental caries CD_5 and a lower threshold E_5 if the presence of dental caries is determined in said step (4.3) and

a step (4.5) of determining that the dental caries is minor if the value of said dental caries CD_5 is equal to or larger than the lower threshold E_5 and determining that the dental caries is severe if the value of said dental caries degree CD_5 is smaller than said lower threshold E_5 .

10 21. The dental caries detecting method according to any one of claims 14 to 20, wherein said n is 2.

22. A dental caries detecting program enabling a computer to carry out the dental caries detecting method according to any one of claims 9 to 20.

15 23. A dental caries detecting method that irradiates a measuring area with ultraviolet light from a light source and detects dental caries based on fluorescence from the measuring area, including:

a first step of obtaining fluorescence from said measuring area as first information, second information, ..., and n -th information for at least two different light intensities U_1, U_2, \dots , and U_n where $U_1 > U_2 > \dots > U_n$;

20 a second step of obtaining a first fluorescence intensity R_1 , a second fluorescence intensity R_2 , ..., and an n -th fluorescence intensity R_n in a first wavelength band selected from a wavelength band from 550 nm to 810 nm and having a wavelength width from 0.1 nm to 260 nm based on said first information, second information, ..., and n -th information;

25 a third step of calculating according to the following formula (5):

$$(R_1 - R_2) + (R_2 - R_3) + \dots + (R_{n-1} - R_n) \quad \dots \text{formula (5)}$$

and

a fourth step of determining that there is a possibility of dental caries if the sign of a result obtained from formula (5) is positive, and determining that the tooth is
30 healthy if the sign is negative or the result is zero.